

## BENEFICATION OF FINE CHROMITES BY LARGE DIAMETER REICHERT SPIRAL AND MULTI GRAVITY SEPARATOR

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### ABSTRACT

There are 26 concentration plants in Turkey in order to treat disseminated chrome ores. At the plants, chromite is lost in the tailings as it necessitates fine grinding for liberation so that effective separation of chromite from the gang minerals can not achieved successfully. The previous studies show that the tailings discharged from concentrators have a size of 40-50% - 0.1 mm with a content of 12-20 Cr<sub>2</sub>O<sub>3</sub>. The amount of this type of tailings is about 3 million tone and industrial scale concentration tests were not carried out up to now.

In this study, the slime tailings of Pulpınar chrome ore of Dedeman Mining Co. in the size of - 0.038 mm with 25.58 Cr<sub>2</sub>O<sub>3</sub> content were tried to be concentrated by gravity methods, namely large diameter(1000 mm) Reichert spiral and Multi Gravity Separator (M.G.S)

### INTRODUCTION

Chromium was first discovered by a Frenchman called Lous Vaugelin in 1797. Chromium element is found in the composition of many minerals, however, it is recovered from spinel group of minerals in the composition of (Mg, Fe<sup>++</sup>)O, (Cr, Al, Fe<sup>+++</sup>)<sub>2</sub>O<sub>3</sub>. Main minerals containing chrome are chromite, Uvarovite, Crocoite, Dietzeite, Phoenicochroite, Bellite, Kemererrite[1,2,3].

Chromite deposits are structurally divided into two groups; stratiform and podiform (Alpine) types. Chromite deposits in Turkey are Alpine (podiform) type and their formation is generally observed in the east-west direction. As a result of intense tectonic activities, various ore types such as massive, banded and noduled (leopard skin) were formed. The accompanying secondary minerals found in Turkish Chromite deposits are dunite, harzburgite, olivine, serpentinite and talc.

Turkey is an important chromite ore producer and has total reserve (proven + probable + possible) 310 million tons of base reserve (proven+probable)[2].

The distribution of chromite licenses are shown in Figure 1.

1.6 million tons chrome ore are produced annually, all the ores are treated in 26 concentration plants[1, 4].

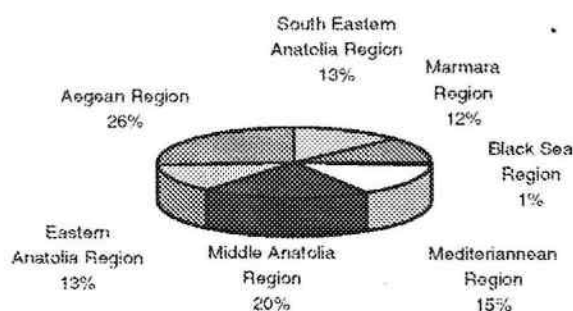


Figure 1. The Distribution of Chromite Licenses in Turkey.

In this plants, chrome ore is concentrated by gravity methods using jigs, heavy media separator, shaking tables and spirals.

In this research, large diameter Reichert (coal) spirals and MGS (Multi Gravity Separator) were used to concentrate chromite slimes and the comparison was made between the results.

### MATERIAL AND METHOD

#### Material

In this study, chromite slimes of classifier overflow from Pulpınar chromite hand sorting plant of Dedeman Mining Co. were used.

Chemical composition, Cr<sub>2</sub>O<sub>3</sub> content and distribution chromite slimes are shown in Table 1 and Table 2 respectively.

Table 1. The chemical composition of Chromite Sample

ELEMENTS	CONTENT (%)
Cr <sub>2</sub> O <sub>3</sub>	25.58
SiO <sub>2</sub>	15.38
Al <sub>2</sub> O <sub>3</sub>	6.22
Fe <sub>2</sub> O <sub>3</sub>	12.06

Table 2. Size Analysis and Cr<sub>2</sub>O<sub>3</sub> Distribution of Chromite Sample

Size mm	Weight %	Cr <sub>2</sub> O <sub>3</sub> Content %	Cr <sub>2</sub> O <sub>3</sub> Distribution %
+0.100	1.7	8.88	0.57
-0.100+0.074	1.4	10.55	0.59
-0.074+0.053	5.0	20.60	4.02
-0.053+0.038+	10.0	23.99	9.37
-0.038+0.025	13.9	26.69	85.45
0.025+0.010	31.1		
-0.010	36.9		
<b>Total</b>	100.0	25.58	100.00

**Method**

Sample was dispersed by mixer before the tests and by screening +0.1 mm particles were removed.

Tests were done by large diameter(1000 mm) Reichert (coal) spiral and laboratory MGS separator.

In the tests with Reichert Spiral, the effect of % solids in the pulp was studied.

Concentration tests with MGS, % solid in the pulp, amplitude, slope, wash water addition and drum speed were investigated so that optimum parameters were determined.

At the end of concentration tests, Cr<sub>2</sub>O<sub>3</sub> contents of products were determined by XRF analysis.

**EXPERIMENTAL**

**Tests With Large Diameter Reichert Spiral**

In the first stage of the experiments, the large diameter Reichert Spiral was used. It is shown in Figure 2.

First % solids in the pulp such as 5 %, 10 % and 15 % were studied to fix optimum % solids in the pulp.

Through preconcentration tests with Reichert Spiral, Cr<sub>2</sub>O<sub>3</sub> content was increased , but recovery was dropped while the % solids in the pulp are raised. As the field of application, it is disadvantageous to operate with high solid ratio as 15,20,25 percents solids sticking to the spiral surface 10 % solids in the pulp was selected and then spiral tests were done in stages as shown in Figure 3.

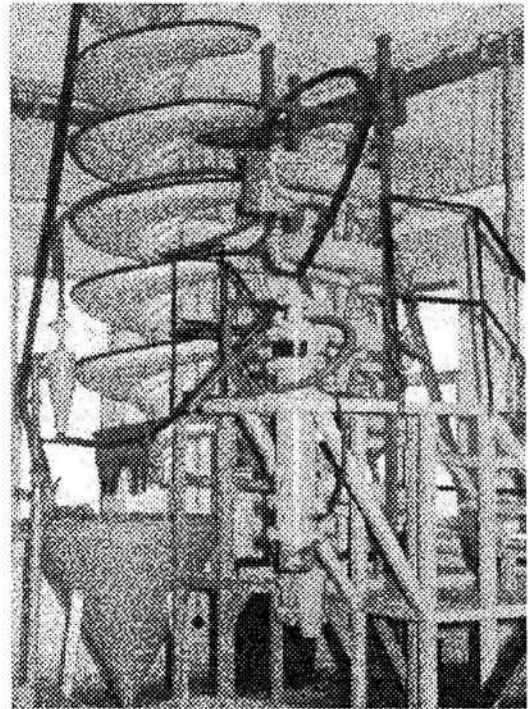


Figure 2. Large Diameter Reichert Spiral

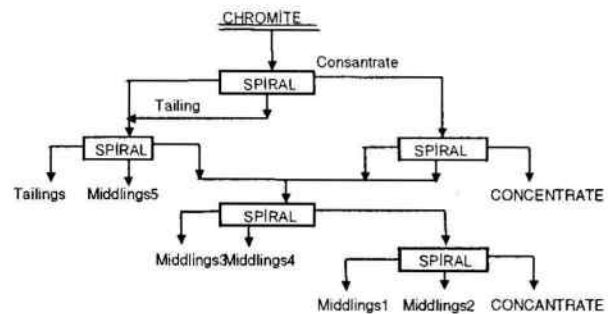


Figure 3. Flow sheet of concentration in stages with large Diameter Spiral

Test Results of concentration in stages with large diameter Reichert spiral are given in Table 3 and Table 4.

Table 3. Results of Large Diameter Reichert Spiral Concentration in Stages

Products	Weight (%)	Cr <sub>2</sub> O <sub>3</sub> (%)	Recovery (%)
Concentrate1	7.20	45.08	12.67
Concentrate2	4.00	44.20	6.90
Middlings1	4.40	35.44	6.08
Middlings2	3.50	30.92	4.21
Middlings3	26.80	27.09	28.29
Middlings4	9.30	25.06	9.08
Middlings5	27.70	19.54	21.08
Tailings	17.10	17.54	11.69
<b>TOTAL</b>	100.00	25.66	100.00

Table 4. Summary of Results with Reichert Coal Spiral Concentration in Stages

Products	Weight (%)	Cr <sub>2</sub> O <sub>3</sub> (%)	Recovery (%)
Concentrate	11.20	44.82	19.57
Middlings	44.00	27.79	47.66
Tailings	44.80	18.77	32.77
<b>TOTAL</b>	100.00	25.66	100.00

A chromite concentrate with 44.82% Cr<sub>2</sub>O<sub>3</sub> was obtained with a recovery of 19.57 % by using large diameter spiral.

#### Concentration Tests with MGS Separator

The following parameters were investigated on the effect of concentration.

- % Solids in the pulp
- Amplitude
- Slope
- Quantity of wash water
- Drum speed

The MGS (Multi Gravity Separator) has been used in the tests is shown schematically in Figure 4.

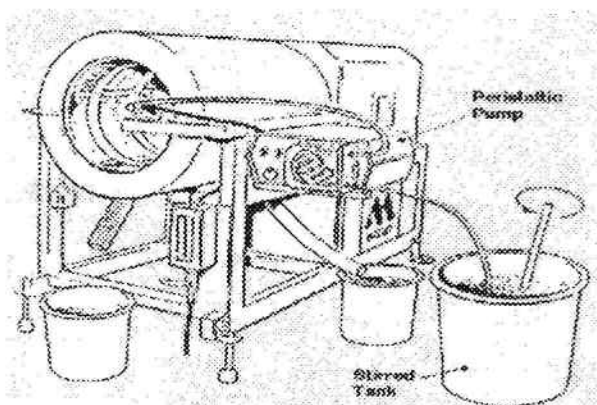


Figure 4. Multi Gravity Separator

When % solid in the pulp was investigated the following parameters were kept constant,

Feed	: 2 l/min
Amplitude	: 15 mm
Slope	: 4°
Wash water	: 4 l/min
Drum Speed	: 180 rpm

The results of tests with MGS is shown in Figure 5.

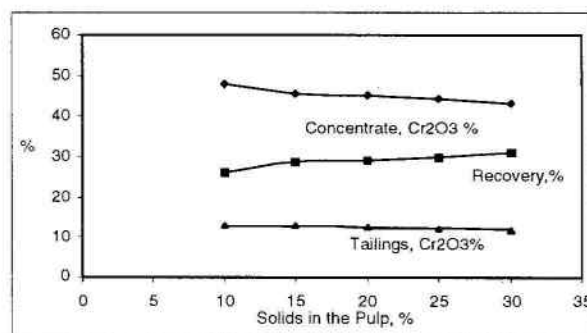


Figure 5. Effect of % Solids in the Pulp on Grades and Recoveries of Chromite.

The most suitable % solids in the pulp was fixed as 10 % where a concentrate was obtained with a grade of %48.03 Cr<sub>2</sub>O<sub>3</sub>.

Amplitude was studied under the following fixed parameters:

Feed	: 2 l/min
% Solids in the Pulp	: 10 %
Slope	: 4°
Wash water	: 4 l/min
Drum Speed	: 180 rpm

The results of tests for amplitude ore given in Figure 6.

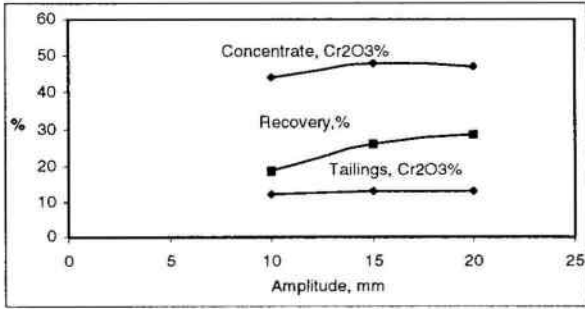


Figure 6. Effect of % Amplitude on Grades and Recoveries of Chromite

The optimum amplitude is found as 15 mm. Slope is studied under the following fixed parameters and results are shown in Figure 7.

Feed : 2 l/min  
 % Solids in the Pulp : 10 %  
 Amplitude : 15 mm  
 Wash water : 4 l/min  
 Drum Speed : 180 rpm

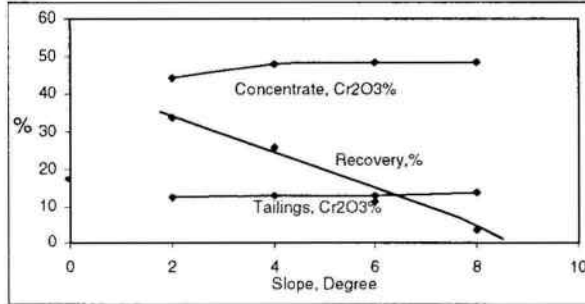


Figure 7. Effect of % Slope on Grades and Recoveries of Chromite

The most suitable slope is found as 4° from the points of chromite grade and recoveries.

The effect of wash water addition was investigated under the following fixed parameters. The parameters are shown below and the results in Figure 8.

Feed : 2 l/min  
 % Solids in the Pulp : 10 %  
 Amplitude : 15 mm  
 Slope : 4°  
 Drum Speed : 180 rpm

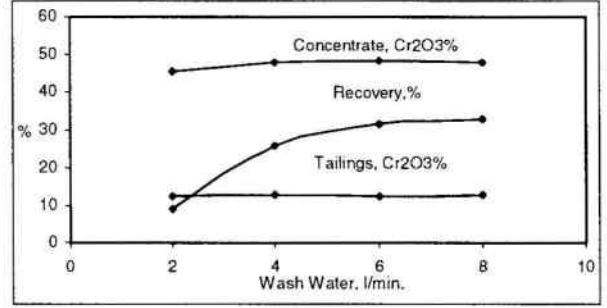


Figure 8. Effect of % Wash Water Addition on Grades and Recoveries of Chromite

6 l/min wash water addition seems to be optimum as indicated in Fig 8.

In order to see the effect of drum speed, the following parameters are kept constant and the results are shown in Figure 9.

Feed : 2 l/min  
 % Solids in the Pulp : 10 %  
 Amplitude : 15 mm  
 Slope : 4°  
 Wash Water : 6 l/min

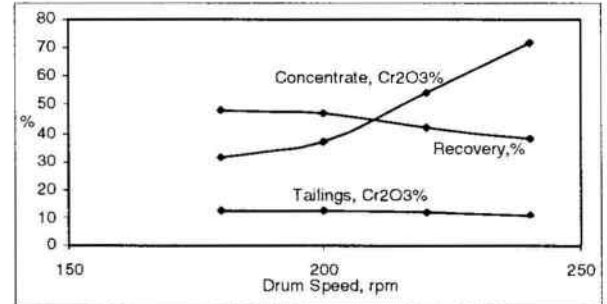


Figure 9. Effect of % Drum Speed on Grades and Recoveries of Chromite.

The optimum drum speed seems to be 180 rpm as shown in Figure 9. At the end of experimental studies, the optimum parameters are determined as follow:

Feed : 2 l/min  
 % Solids in the Pulp : 10 %  
 Amplitude : 15 mm  
 Slope : 4°  
 Wash Water : 6 l/min  
 Drum Speed : 180 rpm

The tests was made on optimum parameters and the results are shown in Table 5.

Table 5. MGS Test under the Optimum Parameters

Products	Weight (%)	Cr <sub>2</sub> O <sub>3</sub> (%)	Recovery (%)
Concantrate	17.50	48.15	31.48
Middlings	25.20	44.08	41.50
Tailings	57.30	12.62	27.02
<b>TOTAL</b>	<b>100.00</b>	<b>25.66</b>	<b>100.00</b>

After determining optimum parameters for MGS, concentration in two stages is carried out. The parameters for first and second stages are shown below and the flow sheet of this test and the results of concentration are shown in Figure 10, Table 6. and Table 7 respectively.

*\*The parameters for first stage:*

Feed	: 2 l/min
% Solids in the Pulp	: 10 %
Amplitude	: 15 mm
Slope	: 2°
Wash Water	: 2 l/min
Drum Speed	: 240 rpm

*\*The Parameters for second stage:*

Feed	: 2 l/min
% Solids in the Pulp	: 10 %
Amplitude	: 15 mm
Slope	: 4°
Wash Water	: 6 l/min
Drum Speed	: 180 rpm

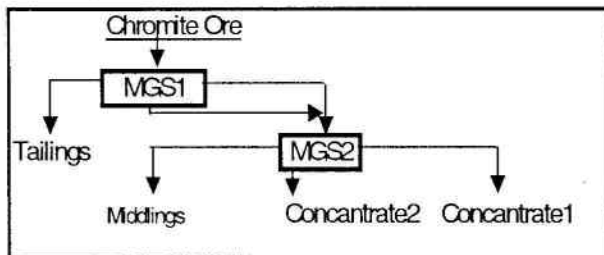


Figure 10. Flow Sheet for MGS Tests in two Stages.

A chromite concentrate with 47.76 % Cr<sub>2</sub>O<sub>3</sub> was obtained with a recovery of 75.40 % by using Multi Gravity Separator.

Table 6. The results of MGS Tests in two Stages.

Products	Weight (%)	Cr <sub>2</sub> O <sub>3</sub> (%)	Recovery (%)
Concantrate1	12.10	48.44	22.07
Concantrate2	27.80	47.46	49.72
Middlings	20.10	14.86	11.26
Tailings	40.00	11.24	16.95
<b>TOTAL</b>	<b>100.00</b>	<b>26.55</b>	<b>100.00</b>

Table 7. Summary of Results on Concentration in Two Stages

Products	Weight (%)	Cr <sub>2</sub> O <sub>3</sub> (%)	Recovery (%)
Concantrate	41.90	47.76	75.40
Tailings	58.10	11.24	24.60
<b>TOTAL</b>	<b>100.00</b>	<b>26.55</b>	<b>100.00</b>

## CONCLUSIONS

Conclusions are given below on the results of concentration of chromite slimes with large diameter Reichert spiral and MGS.

- At the tests with large diameter Reichert spiral, sticking of solids on spiral surface be observed at higher pulp densities.
- Sticking of solids on spiral surface, prevents the increase of Cr<sub>2</sub>O<sub>3</sub> content and recoveries.
- A concentrate of a 44.82 % Cr<sub>2</sub>O<sub>3</sub> and a recovery of 19.57 % can be obtained with large diameter Reichert spiral.
- During the spiral tests, it was observed that better grade concentrate can be obtained by the changes in structural properties of spiral. (for example wash water application horizontantly to spiral surface)
- Tests have shown that saleble chromite concentrate can be obtained with MGS separator where tailings had rather low Cr<sub>2</sub>O<sub>3</sub> content.
- By the application of MGS separator in two stages concentration, a concentrate was obtained with a grade of 47.76 % Cr<sub>2</sub>O<sub>3</sub> and a recovery of 75.40 % whereas tailings of 11.24 % Cr<sub>2</sub>O<sub>3</sub> which can be discharged.
- In concentration of chromite slimes, MGS has given better performance than large diameter Reichert Spiral.

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